PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F16L 55/165	A1	(11) International Publication Number: WO 97/04269
		(43) International Publication Date: 6 February 1997 (06.02.97)

(21) International Application Number: PCT/GB96/01735

(22) International Filing Date: 19 July 1996 (19.07.96)

(30) Priority Data:
9514883.9 20 July 1995 (20.07.95) GB

(71) Applicant *(for all designated States except US)*: POLYTECH RESEARCH & DEVELOPMENT LIMITED [GB/GB]; Polyline Technology Laboratory, Manchester Science Park, Enterprise House, Lloyd Street North, Manchester M15 6SE (GB).

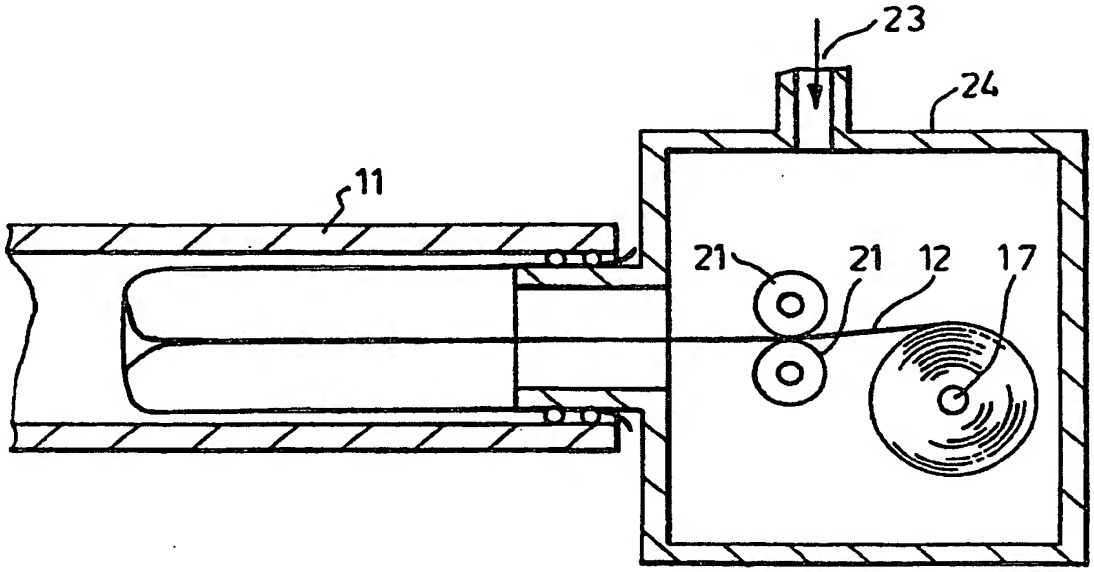
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: CONNOR, Raymond [GB/GB]; 12 Heath Grove, Buxton, Derbyshire SK17 9EH (GB). WILDE, Paul, Anthony [IE/GB]; Flat 2, 13 Park Road, Buxton, Derbyshire SK17 6SG (GB).

(74) Agents: McNEIGHT, David, Leslie et al.; McNeight & Lawrence, Regent House, Heaton Lane, Stockport, Cheshire SK4 1BS (GB).

(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: LINING PIPES



(57) Abstract

There is disclosed a method for lining a pipe in which a tube of film material is attached at one end of the pipe and everted by fluid pressure through the pipe.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia
AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CS	Czechoslovakia
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgystan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakhstan
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LT	Lithuania
LU	Luxembourg
LV	Larvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam

LINING PIPES

This invention relates to lining pipes, especially, but by no means essentially, to lining underground small bore pipes such as domestic water and gas supply pipes.

There is an interest in lining such pipes for a number of reasons. In the case of domestic water pipes which are, in many cases, of considerable age and made of lead, there are problems of lead pollution of the domestic drinking water, quite aside from the problem of leakage from broken pipes, which constitutes a substantial fraction of water usage as well as permitting contamination of drinking water. Gas pipes, too, are not necessarily gas tight, obvious dangers arising therefrom not to mention further waste of natural resources.

There has consequently been considerable interest in replacing or rehabilitating existing pipes, particularly lead pipes. However, no single technique appears to have been economically and technically viable for both long and short lengths of pipe. One traditional approach is to remove and replace the pipe with, for example, a high density polyethylene (HDPE) pipe using the cut and cover method. This is expensive and disruptive to traffic. "No-dig" techniques have been developed in which the pipe is pulled out from an excavation with an attached replacement pipe being pulled through from a remote excavation. This is difficult if not impossible where there are bends in the pipe. Often, it is more convenient to resort to laying a new pipe by the side of the old one using "moling" or directional drilling, which, however, requires the use

of expensive heavy equipment which can cause a great deal of disruption above ground.

Some trenchless methods are subject to inaccuracies in placement of the pipe and it is difficult to change direction or manoeuvre around obstacles.

In recent years, due to the problems described above and in an attempt to use the existing asset, relining techniques have been developed.

One such technique, designed for lead piping, involves lining the pipe with a specially developed polyethylene terephthalate (PET) liner. This is a multi-step operation involving cleaning the pipe using a rotating cable and brush and blowing through the resulting debris, inserting the liner in the form of a thick walled tube, having a diameter less than the internal diameter of the pipe, heating the pipe using circulating hot water to soften it and increasing the pressure to expand it to fit closely to the pipe and blowing the hot water out with compressed air and cooling the pipe. This is a complicated procedure, but has the advantage that quite long lengths of pipe can be rehabilitated with little disruption.

Pipes are also relined with epoxy resin by a number of techniques. In one method, for pipes of diameter no smaller than 7.6 cm, a spray head is pulled through the pipe. In another, a reservoir of epoxy resin is blown through the pipe by compressed air. Epoxy resin has been applied to gas pipes using a lining pig which is also forced through the pipe by compressed air. A major drawback is the long curing time required - up to sixteen hours - which adds considerably to the down-time.

The present invention provides a method for lining pipes which is less expensive, simpler and less time consuming than any of the prior art methods aforementioned, and which has other advantages in its various embodiments as will become clear from what follows.

The invention comprises a method for lining a pipe in which a tube of film material is attached at one end of the pipe and everted by fluid pressure through the pipe.

A similar method has, of course, been employed for a number of years in the structural rehabilitation of sewers. The lining used in that procedure, however, is a heavy-duty thermo setting resin impregnated textile, e.g. polyester fibre felt. The present invention is seen to be an adaption of that technique to the lining of, generally speaking, smaller pipes, often substantially smaller pipes, than the sewers to which the technique is conventionally applied, but using a lining which is quite different not only from the lining used in that technique but also from the linings used hitherto in water and gas pipe rehabilitation.

The fluid pressure may be air pressure. Conventionally, in the tube eversion sewer relining technique, the required pressure is generated by a head of water, although one proposal is to use air pressure in combination with resin impregnation only at the point of eversion as the lining travels down the pipe, air pressure being adequate to evert the lighter, unimpregnated textile material.

The tube diameter may be substantially equal to the pipe inner diameter. Whilst this is clearly a requirement for a structural lining as in sewer rehabilitation, it is

not an absolute requirement for film linings, where tubes of greater or lesser diameter than the pipe can be successfully everted. It has been found, however, that if the tube diameter is substantially equal to the pipe inner diameter, bends even involving elbow joints which have radial steps, can be successfully negotiated. Thus while it would clearly be possible to use, for example, a polyethylene lay flat film tube of smaller diameter than the pipe and expand it, as with the PET liner referred to above, it is preferred, on account of the possibility of negotiating bends with radial steps, to use a lining which is already correctly sized to the pipe.

The tube may be supplied as a layflat tube, which can be unwound from a roll to be fed with the pipe.

The tube may be supplied in a length - usually at least twice the length of pipe to be lined, but not necessarily so, as will be explained below - which is during the lining operation held inside a pressure chamber supplying the eversion pressure. When the length of tube is twice that of the pipe, the pipe will contain, when the tube has been everted through the full length of the pipe, two pipe lengths of tube, one inside the other. The tube may be cut at the remote end of the pipe and the inner length withdrawn, or both lengths left inside.

It is possible, however, to seal the free end of a length of tube equal to the pipe length so that it is blown through the pipe without necessarily dragging a "tail" of tube all the way through the pipe, which could, by friction, especially where multiple bends have to be negotiated, limit the length of pipe that can be lined in a single operation. In this case it may be desirable to attach a weight or drag anchor or a control

string that may be tensioned appropriately to the sealed end to control the eversion process.

The film material may be a polymeric plastic material, which may be a thermoplastic. Polyethylene and polyethylene terephthalate are suitable, especially for lining water and gas pipes.

Such pipes are usually buried, so that access is by excavation. The excavation need not be extensive, however, because the equipment used to supply the tube and pressure can be located above ground and a lead-in pipe e.g. a flexible pipe, attached to the pipe to be lined.

Whilst it is expected that with the use of appropriate materials a permanent, or substantially permanent rehabilitation of lead and/or broken pipes can be achieved, the lining may in some instances turn out to have a limited life, though certainly adequate in any event as a temporary measure. As the lining is of film, if it is sized to the pipe, there is essentially no reduction in pipe inner diameter and therefore carrying capacity. Second and even subsequent lining operations can be carried out either contemporaneously with the first in order to produce a more robust or gas-tight lining or at intervals thereafter in case of wear on the first lining.

Of course, once the lining has been everted through the pipe, the pipe ordinarily already contains a double layer. If the eversion pressure is released once the far end has been secured, the inner layer can be pressed against the outer layer by overpressure from the far end and/or underpressure in the original eversion pressure

space from the original blowing end.

A hardenable foam may be injected into the pipe before or during the lining operation; the foam may be introduced between first and second linings for example into the eversion of the first lining. This can give an element of structural support.

The method can be used to bridge gaps in broken pipes and can accommodate misaligned sections even if the ends have been separated lengthwise - in fact the method can bridge pipes separated and/or misaligned by up to half a diameter.

The invention also comprises apparatus for lining pipes comprising a support for a supply of tubular film material, attachment means adapted to attach an end of the tubular material to a pipe to be lined and fluid pressure means adapted to evert the tube through the pipe.

The support may comprise a roll support for a roll of layflat tube. The attachment means may comprise a tubular insert or fitting for the pipe between which and the inner wall of the pipe the tube can be sealingly clamped. The attachment means may comprise O-ring seals.

The support for the supply of tubular material may have feed roller means mediating the feeding of the material through the pipe. The support may be enclosed in a pressure chamber, which may have a flexible connector to the pipe allowing it to be situated away from and off the axis of the pipe.

For foam insertion as aforementioned, the apparatus may comprise a foam inlet to the space between the tube and the pipe.

Embodiments of apparatus and methods for lining pipes according to the invention will now be described with reference to the accompanying drawings in which :

Figure 1 is a diagrammatic illustration of a domestic water supply pipe lining operation;

Figure 2 is a diagrammatic illustration of a first apparatus;

Figure 3 is a diagrammatic illustration of a second apparatus,

Figure 4 is a diagrammatic illustration of a third apparatus,

Figure 5 is an end view of one form of layflat tube for the operation illustrated in Figure 1,

Figure 6 is an end view of another form of layflat tube for the operation illustrated in Figure 1, and

Figure 7 is a cross-section of one kind of material for the manufacture of tubes as illustrated.

The drawings illustrate methods and apparatus for lining pipe 11 such for example as domestic water supply pipe 11 of Figure 1 which may be in need of rehabilitation due to wear, fracture, leakage, internal encrustation or contamination or which may simply be guilty of being made of lead which dangerously contaminates drinking water to levels above those which are now regulated.

In the methods, a tube 12 of film material, such as polyethylene or polyethylene terephthalate or a composite material as hereinafter explained is attached at one end 13 of the pipe 11 and everted by fluid pressure through the pipe 11.

At the remote end of the pipe it may be advantageous to fit a transparent extension so that the appearance of the end of the tube can be monitored without allowing the tube to expand freely under the eversion pressure. The extension can be long enough to allow the ingress of a sufficient length of everted tube to give a cuff for folding back over the end of the pipe.

As will be seen particularly from Figure 1, the pipe 11 runs from a street water main 14 underground to a domestic stop cock 15, typically through two right angle elbow joints 16. The method can be accomplished by accessing the end 13 of the pipe below street level through a manhole or by excavation. The domestic stop cock 15 can be regarded as the terminal point of the lining operation for present purposes, but, of course, there is no reason why the operation cannot be carried out on all the pipes in the building, provided that they can be accessed or that branched pipes are accommodated, as will be explained presently.

Suction may be applied to the pipe 11 at the stop cock 15 and to assist in the eversion process. In some instances, of course, suction alone might achieve the eversion process even without the use of fluid overpressure at the tube inlet end - this will typically be the case in relatively short, relatively straight and - above all relatively leak-free pipes. A suction device 10 is shown attached to the stop cock 15 in Figure 1.

Figures 2, 3 and 4 illustrate, severally, apparatus for lining pipes 11 comprising a support 17 for a supply of tubular film material 12, attachment means 18 adapted to attach an end 12a of the tubular material 12 to a pipe 11 to be lined, and fluid pressure means 19 adapted to evert the tube 12 through the pipe 11.

The support 17 is a roll support for a roll of layflat polyethylene or polyethylene terephthalate tube 12.

The attachment means 18 comprise a tubular insert for the pipe 11 between which and the inner wall 11a of the pipe 11 the tube 12 can be sealingly clamped with O-ring seals 19.

The support 17 has associated feed rollers 21 mediating the feeding of the tube 12 through the pipe 11. The rollers 21 are operated so as not to allow any drag of the roll feed arrangement to prevent or hinder the eversion of the tube 12 through the pipe 11, and may have an associated measurement device for the length of tube 12 fed into the pipe 11.

In the embodiment of Figure 2, the support means 17 are located adjacent

an air delivery block 22 which includes the attachment means 18 and to which is connected a pressure air supply 23. The tube 12 is fed in through a seal 20. Figure 3 shows how the support means are located in a pressure chamber 24 fed by the pressure air supply 23 and supplying the eversion pressure. A hatch (not shown) permits access to the chamber 24 for changing the roll of material 12. The air delivery block 22 could, of course, be located outside the excavation, e.g. on a truck, and connected to the pipe by a flexible hose. This is so for all embodiments.

The support 17 may have a brake operative to prevent rotation of the roll of film when eversion is held up, e.g. due to a restriction in the pipe 11.

Larger diameter pipes such as the street water main 14 can also be lined in the same way using an appropriate size of liner.

Figure 4 illustrates how for larger pipes such as the street main 14 where some additional reinforcement might be desired, a foam injection nozzle 41 is accommodated to inject a hardenable foam between a spigot 42 constituting the tubular insert 18 and an inner spigot 43 with an intervening annulus from which the foam flows. A first lining 12 from one of two roller supports 17 is everted through the pipe 14, then, once that is in place, eversion pressure is released and the lining secured at both ends. A second, smaller diameter,lining from the other of the roller supports 17 is then everted through the pipe 14. For the second lining, the inner spigot 43 can be used to anchor the end 12a of the tube 12. When the second lining is fully through the pipe 14 it is held under pressure while foam is injected between the first and second linings or between the eversion and the tail of the first lining, the second lining acting as a mould preventing the

foam and first lining collapsing inwardly.

The layflat tube 12 preferably has a like diameter to the internal diameter of the pipe 11, 14. It is found that with a mismatch here, progress of the tube eversion down the pipe can be interrupted and pressure can build up which bursts the tube. Straight runs can be accommodated, but curves, especially 90° elbow joints, are best negotiated using closely matched tube and pipe and also when the support means 17 are inside a pressure chamber as illustrated in Figure 3.

Fortunately, pipes tend to come in standard sizes, such as ½" (12.2mm), ¾" (19mm), 1" (25.4mm), 3" (76.2mm) and a few larger sizes, and so there is no need for a large inventory of tube sizes.

It is, in any event, a straightforward matter to arrange for biaxial orientation of the polymer material to give any desired tube size.

The production of the film essentially involves extruding a tube of molten thermoplastic and continuously inflating it to several times its as-extruded diameter to form a thin tubular product. Typically, the term "film" is associated with thicknesses between about 40 and 400 microns. "Blown" film properties are controlled primarily by crystallinity and molecular weight. Typically the tensile strength increases with density and water vapour transmission rate falls. High molecular weight plastics have improved toughness and impact strength.

The inflation or blowing operation induces significant orientation of the

polymer molecules, which contributes substantially to strength and stiffness and enhances chemical inertness and barrier properties.

Two or more different polymers can be co-extruded. Melt streams can be combined in the extrusion die body or combined outside the due using a feed block. A film material with good barrier properties and chemical inertness can thus be combined with a layer of high stiffness and strength. An adhesive layer can be added (on the inside of the extruded tube) for activation once in the pipe, as by heat from a hot water, air or steam flow through the pipe, to adhere the lining to the pipe wall. Figure 7 illustrates a three layer film with a barrier layer 71, a high strength substrate 72 and an adhesive layer 73.

Suitable materials for the tube include polyethylene, polypropylene, polyvinyl chloride, polyamide, polyvinylidene chloride, ethylene/vinyl acetate, any of which may include additives and stabilisers adapting them to the purpose and the process such as anti-blocking and slip additives to militate against layers sticking together (especially with adhesive layers) on storage on roll, and to facilitate the tube sliding through the everted tube. Any of the materials can be suitably cross-linked for hot or cold curing to set the material in its opened-out form once inside the pipe. An adhesive layer may comprise a heat activated adhesive or resin suitable for bonding to the inside of metallic or polyethylene substrates together with a suitable catalyst.

Conductive and semiconductive polymer and even electronic devices can also be used as or incorporated in the film material for various purposes for example for temperature control or flow or pressure measurement, dual containment, detection of

substances flowing in the pipe and so forth.

While the technique and materials discussed above have been explained primarily in the context of water pipe rehabilitation, they are clearly applicable to the lining of pipes of various diameters for many different purposes. Gas pipes have already been mentioned, a lining applied in accordance with the present invention being able to repair fractured pipes or render more gas-tight existing pipes, perhaps to accommodate a greater gas pressure than the design pressure of the original pipe. Pipes may be adapted for purposes other than the conveying of fluids - the lining may create a waterproof environment, for example, for communication systems.

Whilst simple layflat tube can be successfully everted in suitable pipes, i.e. circular section tube which has been collapsed flat for winding on a roll, it is found advantageous to include at least one gusset in the tube. Figure 5 is an end view of a tube 12 having a single gusset 51; Figure 6 is an end view of a tube 12 having two gussets 61 A simple ungussetted layflat tube has a width equal to πr, where r is the radius of the tube when blown out into circular form. The layflat tube is thus wider than the blown out tube (2r) and this can give rise to difficulties in passing the tube in its flat state through the already opened out tube during the eversion process, especially on long pipe runs with bends and angles. Gusseting reduces the width of the layflat tube. The tube shown in Figure 5 with a single gusset has a width of about 2r, while that shown in Figure 6 has a width of about 1.6r, the broken line circle in each Figure indicating the opened-out circumference.

While the film would ordinarily be supplied to the lining site on rolls from

the film manufacturer, it would be entirely possible to extrude the film at the site - a truck could be specially fitted with an extrusion machine as well as the compressor and other equipment necessary to access and line the pipe.

Mains pipes with ferrules or branch connectionc can be lined by everting the film tube through the pipe and adhering it to the walls by the adhesive technique after which the branch or ferrule is reopened as by a probe or by air pressure to allow the next section to be lined.

CLAIMS

1. A method for lining a pipe in which a tube of film material is attached at one end of the pipe and everted by fluid pressure through the pipe.

2. A method according to claim 1, in which the fluid pressure is air pressure.

3. A method according to claim 1 or claim 2, in which the tube has substantially the same diameter, when installed in the pipe, as the pipe itself.

4. A method according to any one of claims 1 to 3, in which the tube is a layflat tube.

5. A method according to claim 4, in which the layflat tube is gusseted.

6. A method according to claim 5, in which the tube has two gussets.

7. A method according to any one claims 1 to 6, in which the tube is unwound from a roll to be fed to the pipe.

8. A method according to claim 7, in which the length of tube on the roll is at least equal to the length of the pipe through which it is to be everted.

9. A method according to claim 8, in which the length of tube on the roll is equal to at least twice the length of the pipe through which it is to be everted.

10. A method according to any one of claims 1 to 9, in which the lining operation is stopped once the tube has been everted through the full length of the pipe so that there are two lengths of tube inside the pipe.

11. A method according to claim 10, in which both lengths are left inside the pipe as lining.

12. A method according to claim 10, in which one of the lengths is severed from the other and withdrawn from the pipe.

13. A method according to any one of claims 1 to 9, in which the free end of the tube (which need then be only one pipe length long) is sealed enabling it to be blown through the pipe without dragging a 'tail' of tube all the way along the pipe.

14. A method according to claim 13, in which a string or rope is attached to the sealed end to control the eversion process.

15. A method according to any one of claims 1 to 14, in which suction is applied to the pipe at the end thereof remote from that at which the tube enters.

16. A method according to any one of claims 1 to 15, in which the film is caused to adhere to the pipe.

17. A method according to claim 16, in which there is an adhesive compound active between the tube and the pipe.

18. A method according to claim 16 or claim 17 in which the tube is heated whilst in contact with the pipe to cause it to adhere.

19. A method according to any one of claims 1 to 18, in which the film material comprises a polymeric plastic material.

20. A method according to claim 19, in which the material is thermoplastic.

21. A method according to any one of claims 1 to 19, in which the material is thermosetting.

22. A method according to claim 21, in which thermosetting takes place after installation of the tube in the pipe as by pressurised hot water.

23. A method according to any one of claims 1 to 22, in which a hardenable foam is injected into or around the pipe, and hardened.

24. A method according to claim 23, in which the foam is injected between first and second linings.

25. A method according to claim 24, in which the foam is injected into the eversion of the first lining.

26. A method according to any one of claims 1 to 25, in which the film has a thickness less than 200 microns.

27. A method according to any one of claims 1 to 26, in which the film is a homogeneous monolayer film.

28. A method according to any one of claims 1 to 26, in which the film is a multilayer film.

29. A method according to claim 28 in which a surface layer of the film is of a material approved for water transmission.

30. A method according to claim 28 or claim 29, in which a layer provides strength.

31. A method according to any one of claims 1 to 30, in which a supply of tube is held in a chamber sealed to the end of the pipe, an end of the tube sealingly attached to the said end of the pipe, and the chamber is pressurised whereby to effect the eversion operation to pass the tube through the pipe.

32. A method according to any one of claims 1 to 30, in which a supply of tube is fed through a sealing arrangement into a chamber sealed to the end of the pipe, an end of the tube sealingly attached to the said end of the pipe, and the chamber is pressurised whereby to effect the eversion operation to pass the tube through the pipe.

33. A method according to claim 31 or claim 32, in which the chamber has an outlet projection which forms a tubular insert which fits into the end of the pipe and the end of the tube is first everted around the projection then the projection introduced into

the end of the pipe to trap and seal the end of the tube.

34. A method according to claim 33, in which the projection is annular and has an inlet through which a hardenable foam is introduced after the tube has been everted through the pipe or as the tube is being everted through the pipe.

35. A method according to claim 34, in which after the foam has been introduced a second film is everted through the pipe to trap the foam in an annular space.,

36. Apparatus for lining pipes comprising a support for a supply of tubular film material, attachment means adapted to attach an end of the tubular material to a pipe to be lined and fluid pressure means adapted to evert the tube through the pipe.

37. Apparatus according to claim 36, in which the support comprises a roll support for a roll of layflat tube.

38. Apparatus according to claim 36 or 37, in which the attachment means comprise a tubular insert or fitting for the pipe between which and the inner wall of the pipe the tube can be sealingly clamped.

39. Apparatus according to claim 38, in which the attachment means comprise O-ring seals.

40. Apparatus according to any one of claims 36 to 39, in which the support for the supply of tubular material has feed roller means mediating the feeding of the

material through the pipe.

41. Apparatus according to any one of claims 36 to 40, in which the support is enclosed in a pressure chamber adapted for connection to the pipe.

42. Apparatus according to claim 41, comprising a flexible connector between the chamber and the pipe.

43. Apparatus according to any one of claims 36 to 42, in which the support is outside a pressure chamber adapted for connection to the pipe and having a sealed inlet for the material from the support.

44. Apparatus according to any one of claims 36 to 42, comprising an inlet for hardenable foam material connected to the annular space between the tube and the everted tube surrounding it during eversion.

45. A film material in the form of a tube adapted for eversion, and being in the form of a layflat tube.

46. A film material according to claim 45, being gussetted.

47. A film material according to claim 46, having a single gusset.

48. A film material according to claim 46, having two opposed gussets.

49. A film material according to any one of claims 45 to 48, incorporating at least one additive adapted to reduce frictional effects deleterious to unwinding from a roll and eversion.

50. A film material according to claim 49, in which said additive comprises a fatty acid amiole.

51. A film material comprising an homogenous monolayer of synthetic polymeric material.

52. A film material according to claim 51, being of polyethylene.

53. A film material according to claim 51, being of polyethylene terephthalate.

54. A film material according to any one claims 45 to 50 comprising a multilayer film.

55. A film material according to claim 54, having a surface layer of a material approved for water conveyance.

56. A film material according to claim 54 or claim 55, having a layer imparting strength.

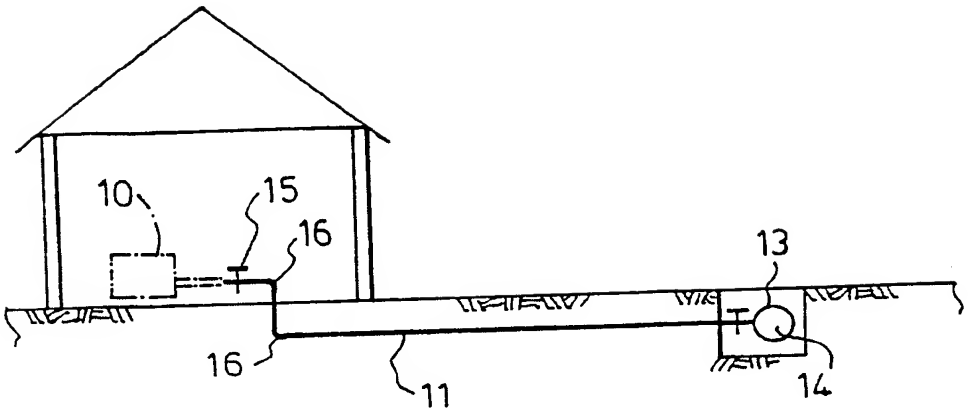


FIG.1

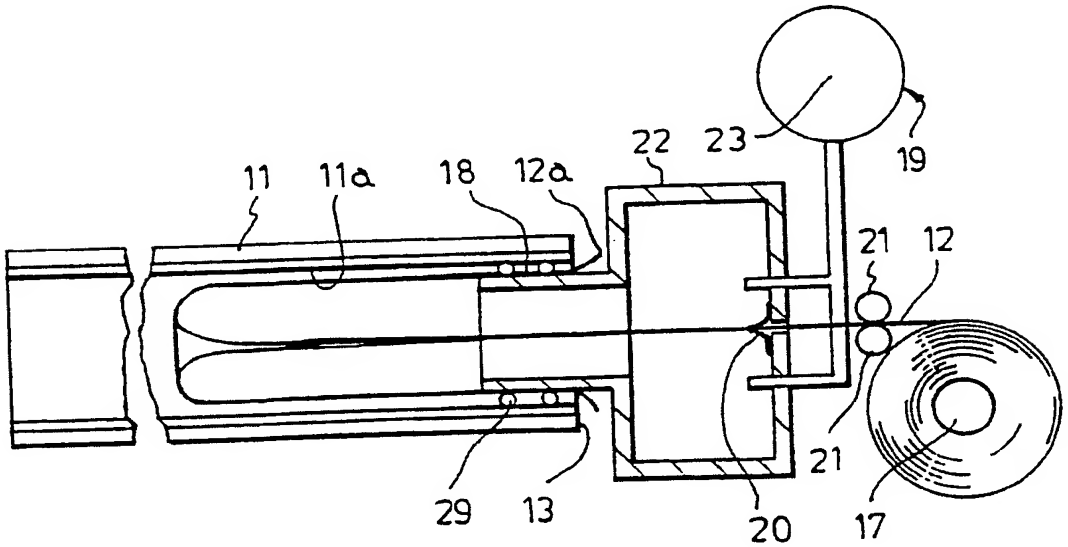


FIG.2

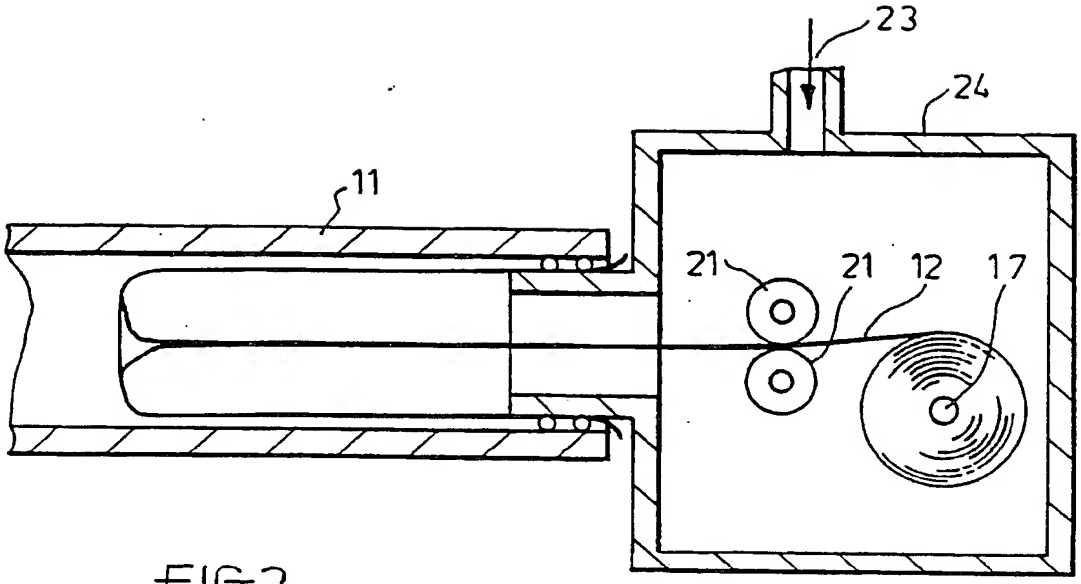


FIG.3

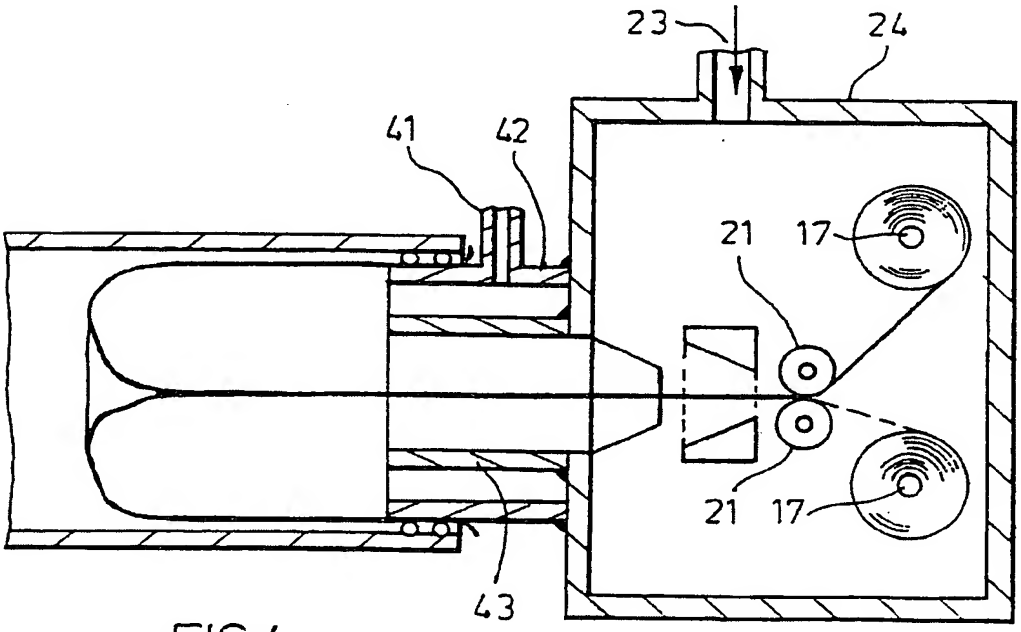


FIG.4

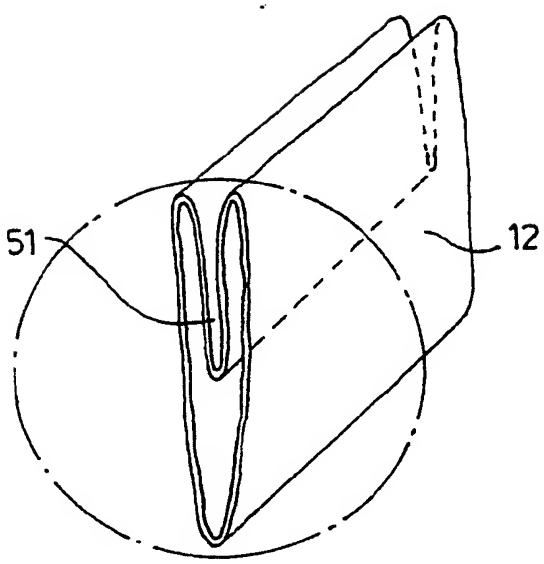


FIG.5

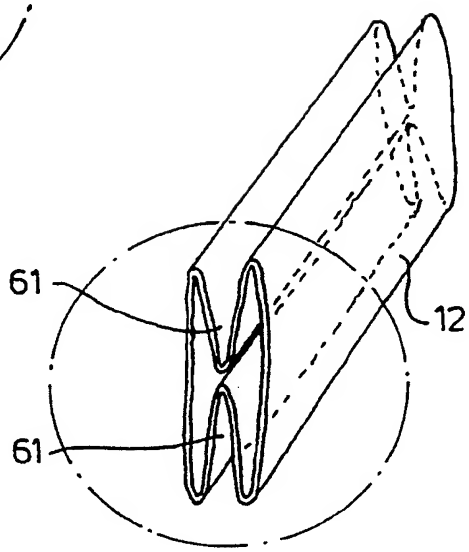


FIG.6

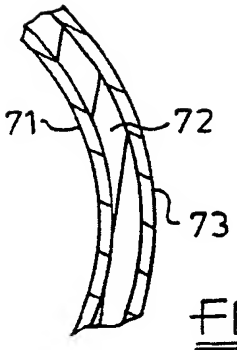


FIG.7

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/GB 96/01735

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16L55/165

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 301 895 (ANGUS FIRE ARMOUR LTD) 1 February 1989	1-8, 13-17, 27-31, 36,41, 45,46, 48,54-56
Y	see the whole document ---	21,22,47
X	GB,A,1 534 441 (MASUDA S) 6 December 1978	1-8, 13-15, 31,33, 36,38,41
	see the whole document ---	
X	US,A,4 770 562 (MUELLER HANS ET AL) 13 September 1988	1,3-5,8, 10,11, 13,14
	see claim 1; figures ---	
	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 December 1996	2 0. 12. 96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Budtz-Olsen, A

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Internat l Application No
PCT/GB 96/01735

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,4 368 091 (ONTSUGA HISAO ET AL) 11 January 1983 see column 5, line 42 - column 6, line 9; claim 1; figures	1,3,4,7, 8,13,14, 16,17, 19,20, 28-30, 32,36, 37,40, 41,43, 45,54-56
X A	WO,A,94 29098 (INSITUFORM LICENSEES B V S A ;INSITUFORM NETHERLANDS B V (NL); BUL) 22 December 1994 see abstract; figures	1,3,13, 14, 16-18,36 22
X Y A	EP,A,0 065 886 (LAURENT JACQUES) 1 December 1982 see page 2, line 29 - page 3, line 10; figures	51,52, 54-56 21,22,47 4-6
X	WO,A,92 01189 (WAVIN BV) 23 January 1992 see claim 5	51,53
A	GB,A,1 002 131 (WOLFF & CO. KG.) 25 June 1965 see page 2, left-hand column, line 8 - line 24; figures	38,39

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Intr tional application No.
PCT/GB 96/01735

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1-50,54-56: A METHOD FOR LINING A PIPE BY EVERTION OF A LINER MADE OF FILM MATERIAL.
51-53: A FILM MATERIAL.

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat l Application No
PCT/GB 96/01735

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0301895	01-02-89	NONE		
GB-A-1534441	06-12-78	JP-C-	1073315	30-11-81
		JP-A-	51092092	12-08-76
		JP-B-	55024324	28-06-80
		DE-A-	2600618	15-07-76
		FR-A-	2297378	06-08-76
US-A-4770562	13-09-88	JP-B-	6041173	01-06-94
		JP-A-	63098420	28-04-88
US-A-4368091	11-01-83	JP-C-	1221885	15-08-84
		JP-A-	56044621	23-04-81
		JP-B-	58054654	06-12-83
		JP-C-	1204007	25-04-84
		JP-A-	55091627	11-07-80
		JP-B-	58038088	20-08-83
		CA-A-	1159347	27-12-83
		DE-A-	2952625	17-07-80
		FR-A-	2445220	25-07-80
		GB-A,B	2042673	24-09-80
WO-A-9429098	22-12-94	AU-B-	671197	15-08-96
		AU-A-	6148594	03-01-95
		CA-A-	2142183	22-12-94
		CN-A-	1096245	14-12-94
		EP-A-	0655969	07-06-95
		FI-A-	950636	13-02-95
		JP-T-	8500406	16-01-96
		NO-A-	950450	07-04-95
EP-A-0065886	01-12-82	FR-A-	2503622	15-10-82
		AR-A-	226266	15-06-82
		CA-A-	1194264	01-10-85
		EG-A-	15611	30-09-86
		OA-A-	7071	31-01-84
WO-A-9201189	23-01-92	NL-A-	9001540	03-02-92
		AT-T-	112375	15-10-94
		AU-A-	8109791	04-02-92

INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat ' Application No
PCT/GB 96/01735

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-9201189		DE-D- 69104360	03-11-94
		DE-T- 69104360	09-03-95
		EP-A- 0537239	21-04-93
		ES-T- 2064111	16-01-95
GB-A-1002131		NONE	